Cy: CStair

MEM 1/20/87

MARTIN MARIETTA

30187I

MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37831

JAN 13 4 01 PM '87

January 9, 1987

Mr. R. J. Spence
Department of Energy, Oak Ridge Operations
Post Office Box E
Oak Ridge, Tennessee 37831

Dear Mr. Spence:

Evaluation of Fish Kill on November 21, 1986 - Upper East Fork Poplar Creek

Enclosed is a summary of findings concerning a fish kill which occurred November 21, 1986, in Upper East Fork Poplar Creek. This incident was discussed with Earl C. Leming of the Tennessee Department of Health and Environment (TDHE) and Dave Hopkins of the Environmental Protection Agency (EPA) during a meeting on December 16, 1986. As a result of this discussion, the enclosed summary is to be forwarded to the TDHE and EPA subsequent to your review.

This summary will be supplemented with data on water temperature, toxicity, and chemical parameters associated with the New Hope Pond effluent at a later date.

Questions may be addressed to L. O. Vaughan at 6-8108.

Very truly yours,

W F Thomas
for Gordon G. Fee
Vice President and
Y-12 Plant Manager

GGF:LOVaughan:lap

Enclosures: As Stated

cc/enc: J. K. Alexander, DOE-ORO
H. W. Hibbitts, DOE-ORO (2)
M. L. Jones/T. R. Butz/C. C. Hill
J. M. Loar
M. E. Mitchell/C. L. Stair
L. O. Vaughan - NoRC
L. F. Willis

#526

ENCLOSURES

Letter, Fee to Spence
January 9, 1987

Letter Title: Evaluation of Fish Kill on November 21, 1986
Upper East Fork Poplar Creek

EVALUATION OF FISH KILL ON NOVEMBER 21, 1986
IN UPPER EAST FORK POPLAR CREEK NEAR THE Y-12 PLANT

J. M. Loar
G. R. Southworth
A. J. Stewart
S. M. Adams
L. M. Adams

Environmental Sciences Division
Oak Ridge National Laboratory

December 19, 1986

Contents

		Page
1.0	BACKGROUND INFORMATION	1
2.0	INVESTIGATIVE STUDIES	3
3.0	EVALUATION OF POTENTIAL CAUSES OF THE FISH KILL (EPIZOOTIC)	7
	3.1 Overcrowding	8
	3.2 Temperature	9
	3.3 Electroshocking	10
	3.4 Pollutants	11
	3.5 Cumulative Stress	12
	3.6 Role of the Pathogen and New Hope Pond	13
4.0	ENVIRONMENTAL CONSEQUENCES OF THE EPIZOOTIC	14
5.0	INTERAGENCY INTERACTIONS	14
6.0	CONCLUSIONS/RECOMMENDATIONS	15
7.0	REFERENCES	18

On Friday, November 21, 1986, at 9:20 a.m., J. M. Loar of the Environmental Sciences Division (ESD) at Oak Ridge National Laboratory, received a call from J. D. Gass of the Health, Safety, Environment and Accountability Division at the Y-12 Plant concerning dead fish in East Fork Poplar Creek (EFPC) immediately below the outfall of New Hope Pond (NHP), a 1.2-ha flow-through retention basin at the east end of the plant. An investigation of the kill was initiated immediately and continued for approximately three weeks. A summary of the findings of this investigation is presented below.

1.0 BACKGROUND INFORMATION

Following notification of the kill, ESD staff conducted a reconnaissance of the upper reaches of EFPC to determine the extent of the kill. A 5.5-km reach of EFPC below NHP was surveyed the morning of November 21. Observations were made at the five bridges between East Fork Poplar Creek Kilometer (EFK) 18.2 at the intersection of Jefferson Avenue and the Oak Ridge Turnpike and EFK 22.0 behind Dean Stallings Ford where the first dead and dying fish were observed. No dead fish were found in approximately 100-m reaches of stream near the bridges downstream of EFK 22.0. Areas near these bridges were also checked on five other days (November 22, 24-26, and December 1) and only one dead fish was found (on December 1 at the Tulsa Ave. bridge at EFK 21.4 or 0.6-km below Dean Stallings Ford).

Systematic surveys of a 1.6-km reach of EFPC between Dean Stallings Ford and NHP were conducted between November 21 and December 15 (Attachment 1). All dead/dying fish were collected by a

1-2 person crew from the ESD working with Wayne Schacher, Anderson County Wildlife Officer in the Tennessee Wildlife Resources Agency (TWRA), on November 21-23. To meet the reporting requirements of the TWRA, fish were identified to species and categorized by 2-in. size classes. With the exception of the first day (November 21), all fish were also categorized by post-mortem changes: (1) no loss of color, indicating recent death (less than a few hours); (2) pale color, rigid body without signs of decomposition; and (3) decomposed, with only fragments of the skeleton present in worse cases. Fish in the latter category were presumed to have died on the preceding day and consequently were added to the counts of fish in the first two categories for that date to arrive at the number killed per day as shown in Attachment 1.

Based on these surveys, the fish kill can be described as follows:

(1) A total of 1,148 dead or dying fish were collected from EFPC, and all but two individuals were stonerollers (Campostoma anomalum);

(2) Most of the fish collected were hemorrhaging (bleeding) from the gills, pectoral/pelvic fins, and/or anus;

(3) The kill began early in the morning of November 21 and continued over a two-week period through at least December 5; no evidence was found, such as decomposed remains, to indicate that fish were dying prior to November 21;

(4) 90% of the fish died on the first two days;

(5) Numerous live fish, including stonerollers, were observed throughout the 1.6-km reach of EFPC below NHP; and

(6) Dead crayfish were also found in relatively low numbers (maximum of 13 on November 23).

2.0 INVESTIGATIVE STUDIES

Intensive sampling of water quality at the outfall of NHP and downstream was initiated by staff at the Y-12 Plant immediately after notification of the fish kill. The preliminary data were reviewed at a 3-h meeting with representatives of DOE, ESD, and the Y-12 Plant on the morning of November 24. Information was received regarding elevated levels of total mercury (Hg) of 30-40 ppb that were observed on November 19, 20, and 21 with the on-line mercury analyzer at the outfall of NHP; normal concentrations usually range from 1 to 3 ppb. Some of the peaks were correlated in time with the removal of a downstream plug in the storm sewer line immediately south of Building 9201-4. This long, mercury-contaminated line was being cleaned as part of the remedial action program to reduce mercury in plant effluents. Removal of the plug caused the release of approximately 30-50 gal. of water. Cleaning operations were terminated on November 21 but resumed again on December 1, following a second meeting held that morning between staff from DOE, ESD, and the Y-12 Plant. Criteria that were considered in the decision to resume the cleaning operation included (1) knowledge of why the fish died, (2) return of water quality at the outfall of NHP to pre-kill conditions, (3) information indicating that either the kill was over or near termination, and (4) turbidity in EFPC was low enough to permit monitoring of the fish populations in the stream after cleaning operations resumed.

To investigate the hypotheses that mercury releases at the Y-12 Plant were associated with the fish kill, laboratory toxicity tests were conducted on November 25 with stonerollers collected from an uncontaminated region of White Oak Creek above ORNL. Sludge removed from the contaminated sewer line and deposited in the northwest sludge basin was added to several aerated aquaria in the Aquatic Ecology Laboratory of the ESD at approximate concentrations of 30 g/L, 15 g/L, and 0.5 g/L. A control aquarium had a turbidity equivalent to that in the low-concentration aquarium (23 NTU). Although mortality was related to concentration, the fish probably died from the high turbidity (200 NTU) occurring at the two highest concentrations. Fish dying in this test did not exhibit the same symptoms (e.g., hemorrhaging) observed in fish dying in EFPC, and observations of the gills of the fish that died in the high turbidity aquaria showed higher than normal secretions of mucus, a general indicator of gill invitation. The test results do not support the hypothesis that Hg-containing sludge discharged during the storm sewer cleaning operations caused the fish kill but must be regarded as inconclusive due to the mortality observed in the test.

As part of the EFPC Biological Monitoring and Abatement Program (BMAP), as specified in Part III(C): Special Condition No. 7 of the National Pollutant Discharge Elimination System (NPDES) permit for the Y-12 Plant, ambient toxicity testing is routinely conducted at the outfall of NHP. In the 7-d, mini-chronic test, a microcrustacean (Ceriodaphnia affinia/dubia) and the fathead minnow (Pimephales promelas) were exposed to water samples collected daily at the outfall of NHP, beginning on November 18. Survival of Ceriodaphnia was 80% and was not significantly different ($\alpha = 0.05$) from the controls (reconsituted hard water), whereas survival of fathead minnows was 78% and was significantly different from controls. However, no difference was observed in the daily mortality rates of the fathead minnow in the November 18-25 test compared with tests conducted on November 4-11 and December 3-10.

The literature on mercury toxicity was also reviewed. Mercuric salts exhibit acute toxicity to freshwater fish in the 15 to 500 ppb (as Hg) range, and to Daphnia magna at 5 to 13 ppb. The lower limits of these ranges approximate levels of total Hg present in the NHP discharge during periods of high mercury release, such as those that occurred the week of November 17. Toxicity tests are performed using dissolved mercuric salts; however, Hg measurements made on NHP discharge water represent the sum of dissolved and particle-associated Hg. The latter form is relatively inert with respect to acute toxicity. Thus, assessing the toxicological significance of Hg in these waters requires reasonable estimates of the distribution of Hg between dissolved and particulate phases.

Studies of the phase distribution of Hg were conducted during the summer of 1986 by R. R. Turner of the ESD. His findings indicate that 10-25% of the total Hg in NHP discharge was in the dissolved form under summer temperature and flow conditions and normal (1-3 ppb) Hg concentrations. Abnormally high Hg levels at the outfall of NHP could result from (1) disturbance of Hg-contaminated sediments, in which case the fraction of Hg that is particle-associated would increase or

(2) mobilization of dissolved Hg by oxidants, etc., which would result in a higher-than-normal fraction of the Hg being in the dissolved state. Since either case is possible, and no measurements of Hg phase partitioning have been made at these levels, a conservative assumption would be that 50% of the Hg is in the dissolved form. With this assumption, total Hg levels in excess of 25 ppb in the NHP discharge would be at levels shown to be acutely toxic to channel catfish (*Ictalurus punctatus*), *Daphnia magna*, and a European dace (*Phoxinus phoxinus*). However, this level would be more than a factor of ten below Hg concentrations acutely toxic to other sensitive species, such as rainbow trout (*Salmo gairdneri*).

In addition to monitoring water quality, conducting toxicity tests, and evaluating the toxicological significance of elevated mercury levels in the outfall of NHP, an investigation of other possible causes of death was initiated on November 24. Mr. Charles Carlson, a fish disease specialist with the U.S. Fish and Wildlife Service (USFWS), was contacted by S. M. Adams for assistance with the investigation. Mr. Carlson visited ORNL on November 26. He examined dead fish collected and frozen on November 21 and 25 and live fish collected on November 26. After the fish were examined for internal and external parasites, bacterial samples from the kidneys were obtained for culture and returned to the USFWS laboratory near Asheville, North Carolina. After the cultures had incubated for several days, Mr. Carlson called S. M. Adams with the results on Monday, December 1, prior to the meeting held that day; written confirmation of these results was obtained several days later

(Attachment 2). From these studies and other investigations (e.g., Pippy and Hare 1969; Wedemeyer et al. 1976), as well as individual conversations with Mr. Carlson by S. M. Adams and by J. M. Loar on December 1, the cause of death can be summarized as follows:

(1) The direct cause of death was due to bacterial hemorrhagic septicemia (BHS), also called motil aeromonad septicemia, an infectious bacterial disease often encountered in many intensive fish culture systems;

(2) The disease-causing organism (or pathogen) was Aeromonas hydrophila which is normally present in most waters;

(3) BHS is a stress-medicated disease; i.e., the host (fish) must interact with the pathogen in a stressful environment that lowers the resistance of the fish to disease;

(4) Environmental factors that are predisposing to epizootics of aeromonad/pseudomonad hemorrhagic septicemias include (1) pre-existing protozoan infections, (2) inadequate pond cleaning leading to increased bacterial loads in water, (3) increased particulate matter in water, (4) handling, (5) crowding, (6) low oxygen, and (7) chronic sublethal exposure to a variety of contaminants, including heavy metals, pesticides, and PCB; and

(5) No evidence of an association between the dead crayfish and BHS was collected.

3.0 EVALUATION OF POTENTIAL CAUSES OF THE FISH KILL (EPIZOOTIC)

In developing hypotheses about the cause of the epizootic, several potential sources of stress were identified and evaluated, including

(1) overcrowding, (2) temperature and rapid changes in temperature, (3) electroshocking, (4) exposure to elevated levels of pollutants, especially Hg, and (5) a combination of stresses. The role of the pathogen and NHP in initiating the epizootic was also considered. Each of these hypotheses is discussed below.

3.1 OVERCROWDING

The high population density required for intensive fish culture is a primary factor responsible for disease outbreaks or epizootics (Wedemeyer et al. 1976). The significance of high densities or overcrowding as a source of stress to the stoneroller population below NHP, however, is unclear because the species normally forms large schools while foraging. Moreover, the density of 1.93 individuals/m^2 observed in November 1986 in EFPC approximately 200 m below NHP was similar to that found in May at other sites located 5 to 15-km downstream and was more than a factor of two lower than the density observed in White Oak Creek east of the ORNL site boundary (Loar et al. 1986). No evidence of BHS disease in the White Oak Creek population has been reported.

Overcrowding is not only a stressor but also an agent that enhances the spread of infectious diseases, such as BHS. Stoneroller densities below NHP have increased by a factor of 10 over the past six months (Attachment 3); high densities were first observed in this region of EFPC in July (Ryon 1986). The small population size may account, in part, for the absence of BHS in 1985. Although the densities of most species also increased over this same period in this region of EFPC, only the striped shiner (<u>Notropis chrysocephalus</u>) had a density similar to that of the stoneroller. This species is an insectivore, and its feeding habit differs substantially from that of the stoneroller. Moreover, the common shiner (Notropis cornutus), a close relative of the striped shiner, was apparently unaffected by an epizootic of Aeromonas liquefaciens (= hydrophila; Wolke 1975) in the Miramichi River in New Brunswick (Pippy and Hare 1969).

The feeding habits of the stoneroller, in addition to their recent high densities below NHP, may explain why this species was the only one affected by the epizootic. The stoneroller is an herbivore that grazes on periphyton (attached algae) that are abundant on rock surfaces below NHP. While feeding, stonerollers ingest particulate matter, including fish feces, that settles on the stream bottom. Ingestion is a major pathway in the transmission of BHS between individuals in a population (Wolke 1975). Crowding of a bottom-dwelling species may also explain why the disease is commonly observed in pond culture of catfishes. Although other "bottom-dwelling" fishes inhabit upper EFPC, including the white sucker (Catostomus commersoni), a species that is susceptible to bacterial disease caused by Aeromonas hydrophila (Pippy and Hare 1969), their densities are at least one or two orders of magnitude below the density of stonerollers.

3.2 TEMPERATURE

Like overcrowding, temperature can be a source of environmental stress and enhance the transmission of BHS. In salmonids (trouts), for example, epizootics due to BHS can increase dramatically at temperatures above 7 to 10°C (Wedemeyer et al. 1976). Available data suggest that the thermal environment below NHP could have enhanced the spread of the pathogen. Based on continuous strip chart recordings from a Peabody Ryan Model J-90 thermograph that was installed in 1985 as part of the BMAP, water temperatures prior to November 21 never fell below 15°C at a site approximately 200 m below NHP. Maximum daily temperatures over the same time period often exceeded 20°C.

The thermograph record was also reviewed to determine if the significant drop in air temperatures on November 13-14 (due to passage through the region of the first major cold front of the fall) could have caused a correspondingly abrupt change in water temperature and triggered the outbreak of BHS. The maximum water temperature just prior to the cold front was 20.8°C at 1600 h on November 12. With the exception of a slight rise in temperature in late afternoon of the following day, a steady decline in stream temperature occurred over the next 36 h (from 20.8°C to 13.1°C at 0600 h on November 14). The maximum rate of change (0.5°C/h) occurred between 1700 h and midnight on November 13 when the water temperature fell from 17.5°C to 14.0°C. Such a change in water temperature was probably not sufficient to have stressed the stoneroller populations and initiated the epizootic.

3.3 ELECTROSHOCKING

Another potential source of stress on the fish populations below NHP was electroshocking, a technique routinely used to estimate fish population size. Although Mr. Carlson believes electroshocking conducted on October 24, 1986, may have caused the outbreak of BHS approximately four weeks later, the evidence is not convincing. The validity of the electroshocking hypothesis rests on the assumption that the kill area was confined to the first large pool immediately below the outfall of NHP. More extensive electroshocking than that used on October 24 was employed on November 10 during quantitative sampling of the fish populations in a 116 m reach of EFPC approximately 200 m below NHP. At this time, three consecutive passes with two electroshocking units (compared to one pass with a single unit in October) were made through the study reach. Fish were anesthetized with tricane methanesulfonate, weighed, and measured, then returned to the stream. Even with these additional sources of stress, the mortality of stonerollers was less than 5%, whereas that of the smaller striped shiner, a species unaffected by the epizootic, was substantially higher (43%). Sampling mortality of the other 10 species combined was 4%. Because the mortality of stonerollers was high during the October 24 sampling trip, it is possible that the population in only this area was under stress from some unknown source (e.g. extreme overcrowding). The additional stress of the electroshocking could have had both immediate and latent effects (i.e., initiation of the epizootic four weeks later). Although this hypothesis cannot be rejected, additional evidence would be required before electroshocking was accepted as the stress that caused the outbreak of BHS.

3.4 POLLUTANTS

Similarly, it does not appear that the epizootic was caused by elevated levels of mercury from a storm sewer cleaning operation. Support for this hypothesis is the correlation in time between the cleaning operations and the fish kill. The laboratory toxicity tests and the published acute toxicity data do not confirm the hypothesis. Moreover, the Hg concentration in the gut of a composite sample of dead stonerollers from below NHP was only 8 $\mu g/g$, wet weight; whereas Hg concentrations in the surficial sediments of the stream in this area range from 20 to 150 $\mu g/g$. Consequently, stress caused by the uptake of Hg adsorbed to suspended particulates seems unlikely. However, like many other possible explanations for the kill, the role of elevated Hg levels in the water in the fish kill can not be refuted based on the available evidence.

3.5 CUMULATIVE STRESS

The epizootic might have been caused by cumulative stress. According to this hypothesis, each of the previously mentioned factors (overcrowding, temperature, electroshocking, and elevated Hg levels) were probably not sufficient to have initiated the outbreak of BHS. However, if it is assumed that they occurred within the same general time frame (approximately a four-week period prior to the kill), then the fish experienced a cumulative or synergistic stress, eventually resulting in a weakened condition characterized by reduced resistance to disease. Under stress, the immune system of the host (fish) dysfunctions and the individual is highly susceptible to disease (Wedemeyer and McLeay 1981; Shulman 1974). Cumulative stress caused by a rare sequence of natural environmental events was the probable cause of a large kill of gizzard shad (Dorosoma cepedianum) in Watts Bar Reservoir in 1984 (Adams et al. 1985).

3.6 ROLE OF THE PATHOGEN AND NEW HOPE POND

The last hypothesis regarding the cause of the epizootic below NHP emphasizes the role of the pathogen, Aeromonas hydrophila, and the environmental conditions in NHP. The environment below NHP is assumed to have been stressful for some time prior to the kill due to elevated temperatures, overcrowding, and/or chronic exposure to pollutants. In this case, the epizootic could have been caused by high pathogen population levels in NHP. Although fish may have been stressed prior to outbreak of BHS on November 21, as indicated by the high mortality that occurred during an electroshocking episode on October 24, no epizootic was observed because of a presumably low pathogen population at that time. Based on data obtained from the BMAP, significant changes occurred (i.e., senescence) in the aquatic macrophytes in NHP between September and December. Such natural seasonal cycles of the pond vegetation can, in turn, affect the redox potential of the sediments, and the types and concentrations of dissolved and particulate organic matter present in and exported from the pond. Presumably these changes could also have enhanced the bacterial loading to upper EFPC. Drying commercial fish ponds at least once a year is recommended as one method of reducing the buildup of organic matter and fish pathogens in pond bottoms (Wedemeyer et al. 1976). By comparison, NHP was last cleaned (i.e., dredged) almost 15 years ago. The hypothesis that pathogen populations in the pond increased significantly during the fall and ultimately triggered the outbreak of BHS lacked direct verification. Virtually nothing is known of microbial population dynamics in NHP, and additional studies seem warranted.

4.0 ENVIRONMENTAL CONSEQUENCES OF THE EPIZOOTIC

The impact of the epizootic on the stoneroller population in upper EFPC can be estimated from data obtained during the BMAP. A population size of 1,047 individuals was calculated for a 116-m reach of EFPC downstream of NHP in November 1986 (Attachment 3). Assuming that the stoneroller population density in this study section is representative of that over a much larger reach of upper EFPC, then, by simple extrapolation based on stream length, the estimated stoneroller population in the 0.5-km reach of EFPC between Bear Creek Road (EFK 23.15) and NHP (EFK 23.65) is 4,513 individuals. Although dead fish were actually collected over a much larger reach (1.6 km), it was assumed that the actual area of the kill was probably more limited. Therefore, a 0.5-km rather than 1.6-km reach was used in the calculations. The loss of 1,146 individuals due to the epizootic (Attachment 1) represents a 25% reduction in the stoneroller population of upper EFPC. Recognizing that (1) not all the fish that died from the epizootic were enumerated (although staff in ESD and W. Schacher of TWRA agree that the collection efficiency was relatively high; Schacher 1986) and (2) actual densities just below NHP may have been much higher than 9 fish/m of stream, the estimated mortality probably ranged from 20-30% of the population.

5.0 INTERAGENCY INTERACTIONS

Successful investigation of this (or any) fish kill required extensive interaction and cooperation between several parties, including various organizations within the investigation team (ORNL and Y-12 Plant staffs) and the appropriate regulatory agencies (TWRA and TDHE). These interactions are summarized in Attachment 4.

6.0 CONCLUSIONS/RECOMMENDATIONS

The direct cause of the fish kill that was first observed on November 21 just below the outfall of NHP is attributed to an outbreak of BHS, a stress-mediated disease common in commercial fish culture operations. The pathogen was identified as Aeromonas hydrophila by Mr. Charles Carlson, a fish disease specialist with the U.S. Fish and Wildlife Service, who analyzed kidney samples taken from stonerollers collected below NHP. Of the 1,148 dead fish collected in a 1.6-km reach of EFPC downstream of NHP, 1,146 were stonerollers. The disease resulted in a 20-30% reduction in the stoneroller population within a 0.5-km reach of EFPC below NHP. Their high population densities, strong schooling behavior, and unique benthic feeding habit, in combination with favorable stream temperatures, probably explain why only stonerollers were affected and how the disease was so rapidly transmitted among individuals in the population, as evidenced by the fact that 90% of the mortality occurred on the first two days of the epizootic.

The cause of the epizootic (i.e., the events or stresses that resulted in an outbreak of BHS at this particular time) cannot be identified, although several hypotheses were considered. Overcrowding and temperature were probably more important in promoting the rapid spread of the disease than in initiating the epizootic. Moreover, the rapid decrease in water temperature that occurred approximately one week prior to the outbreak of the disease was probably not a significant factor. Instead, the outbreak may have been caused by (1) electroshocking, (2) elevated levels of mercury that were associated with the cleaning of a highly contaminated storm sewer line, (3) cumulative stress to these and other unidentified physical or chemical stressors, or (4) changes in environmental conditions within NHP that enhanced the growth of the pathogen population.

For an epizootic of BHS to occur, the host (fish) must interact with a pathogen in a stressful environment. Consequently, to control future outbreaks of the disease, information is needed on both the population dynamics of the pathogen and the source(s) of stress in the environment. For example, additional studies are required to identify environmental conditions that promote the growth of _Aeromonas hydrophila_ populations in NHP. On the other hand, electroshocking for the purpose of collecting redbreast sunfish (_Lepomis auritus_) that are used in the bioaccumulation and biological indicator studies of the BMAP can be performed in a manner that minimizes the exposure of dense schools of stonerollers to electric current. Finally, if total Hg levels in the discharge from NHP exceed 25 ppb, it is recommended that Y-12 Plant staff (1) notify J. M. Loar of the Environmental Sciences Division at ORNL and (2) make frequent observations near the discharge for evidence of an incipient fish kill. Because the cause of the epizootic was not conclusively identified, control of future outbreaks may be difficult to achieve. However, by identifying significant chemical and biological processes in NHP, restricting electroshocking activities, and controlling Hg releases from NHP, the probability of occurrence of another BHS epizootic is minimized to the extent possible based on the available information.

7.0 REFERENCES

Adams, S. M., J. E. Breck, and R. B. McLean. 1985. Cumulative stress-induced mortality of gizzard shad in a southeastern U.S. reservoir. Env. Biol. Fish. 13:103-112.

Carle, F. L., and M. R. Strub. 1978. A new method for estimating population size from removal data. Biometrics 34:621-630.

Loar, J. M., S. M. Adams, J. M. Giddings, J. F. McCarthy, G. R. Southworth, J. G. Smith, and A. J. Stewart. Biological Monitoring and Abatement Program for East Fork Poplar Creek. ORNL/TM-10265. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 92 pp. (In press).

Loar, J. M., S. M. Adams, B. G. Blaylock, H. L. Boston, M. A. Huston, B. L. Kimmel, C. R. Olsen, J. G. Smith, G. R. Southworth, A. J. Stewart, and B. T. Walton. Biological Monitoring Plan and Abatement Program for White Oak Creek watershed and the Clinch River. Draft Report, Oak Ridge National Laboratory, Oak Ridge, Tennssee. 182 pp.

Pippy, J. H. C., and G. M. Hare. 1969. Relationship of river pollution to bacterial infection in salmon (<u>Salmo salar</u>) and suckers (<u>Catostomus commersoni</u>). Trans. Amer. Fish. Soc. 98:685-690.

Ryon, M. G. 1986. Qualitative survey of fish populations at EFK 23.4. Memo to J. M. Loar, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, July 17, 1986. 1 p.

Schacher, W. 1986. Personal communication from W. Schacher, Tennessee Wildlife Resources Agency, to J. M. Loar, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, November 23, 1986.

Shulman, G. E. 1974. Lifé cycles of fish: Physiology and biochemistry. John Wiley and Sons, New York. 258 pp.

Wedemeyer, G. A., F. P. Meyer, and L. Smith. 1976. Environmental stress and fish diseases. Book 5 in S. F. Snieszko and H. R. Axelrod (eds.), Diseases of Fishes. T. F. H. Publications, Inc., Ltd., Hong Kong.

Wedemeyer, G. A., and D. J. McLeay. 1981. Methods for determining the tolerance of fish to environmental stressors. In: A. D. Pickering (ed.). Stress and Fish. Academic Press, New York.

Wolke, R. E. 1975. Pathology of bacterial and fungal diseases affecting fish. pp. 33-116. In: W. E. Ribelin and G. Migaki (eds.). The Pathology of Fishes. University of Wisconsin Press, Madison, Wisconsin. 1004 pp.

ATTACHMENT 1

Number of dead/dying fish collected over a 1.6-km reach of East Fork Poplar Creek downstream of New Hope Pond. NS = no survey was conducted.

Date	No. of fish collected: Stoneroller	Others	Cumulative no. of fish
11-21-86	673	1	674
11-22-86	355		1,029
11-23-86	77	1	1,107
11-24-86	13[a]		1,120
11-25-86	17		1,137
11-26-86	0[a]		1,137
11-27-86	NS		--
11-28-86	NS		--
11-29-86	NS		--
11-30-86	NS		--
12-1-86	4		1,141
12-2-86	0[a]		1,141
12-3-86	2		1,143
12-4-86	1		1,144
12-5-86	4		1,148
12-6-86	NS		--
12-7-86	NS		--
12-8-86	NS[b]		--
12-9-86	NS[b]		--
12-10-86	NS[b]		--
12-11-86	NS[b]		--
12-12-86	0		1,148
12-15-86	0		1,148

[a]Actual number of dead fish was probably underestimated ~~due~~ to turbid water.

[b]No survey was conducted due to high flows and turbidity.

Attachment 2

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Hatchery Biologist-Area
P. O. Box 158
Pisgah Forest, North Carolina 28768

December 2, 1986

Rec'd 12-5-86 JML

Marshall Adams
Building 1505
Mail Stop 36
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, TN 37831

Dear Marshall,

I have completed the laboratory tests of kidney material taken from the stonerollers (Campostoma anomalum) at your laboratory on November 26, 1986.

As I reported to you yesterday during our telephone conversation the stonerollers were infected with the bacterium Aeromonas hydrophilia which causes the fish disease bacterial hemorrhagic septicemia (also known as abdominal dropsy, motil aeromonad septicemia, red pest, etc.). These bacteria were isolated on tryptic soy agar (TSA) slants inoculated with kidney material from the stonerollers. 4/4 cultures were positive for Aeromonas hydrophilia from frozen stonerollers collected on November 25, 1986, 2/3 positive from frozen stonerollers collected on November 21, 1986, and 1/2 positive from fresh stonerollers collected on November 26, 1986.

This group of bacteria are found in all natural water and also compose part of the normal intestinal microflora of healthy fish. They can cause the death of fish when they invade internal organs and begin to produce toxins. Stress can initiate an active epizootic of bacterial hemorrhagic septicemia in feral and cultured fish populations. Low oxygen, high water temperatures, handling, crowding, are some of the stress factors which can weaken the fish. The two pools in which the stonerollers died were electrofished last month. This may have produced enough stress on the fish to provoke the epizootic.

Sincerely

Charles P. Carlson

Charles P. Carlson

cc: James M. Loar

ATTACHMENT 3

Estimated size of the stoneroller population ($\hat{N}_S$) and the total fish population ($\hat{N}_T$) in a 116-m reach of East Fork Poplar Creek. The study site is located approximately 200 m below the outfall of New Hope Pond. Population estimates are based on the three-pass removal method (Carle and Strub 1978).

Sampling date	$\hat{N}_S$	$\hat{N}_T$	% stonerollers ($\hat{N}_S/\hat{N}_T$)
May 14, 1985	0	51	0
October 22, 1985	6	341	2
January 29, 1985	0	104	0
March 11, 1986	11	278	4
May 15, 1986	0	81	0
November 10, 1986	1,047	2,450	43

ATTACHMENT 4

Chronological sequence of interactions between various parties responsible for the investigation of the fish epizootic that occurred in November 1986 in East Fork Poplar Creek below New Hope Pond. Interactions between staff members of the Environmental Sciences Division (ESD) at Oak Ridge National Laboratory are not included.

Date	Type of interaction: Phone call	Type of interaction: Meeting	Principal parties[a]	Subject
11-21-86	X		J. D. Gass (Y-12) J. M. Loar (ESD)	Notification of fish kill
11-21-86		X	J. M. Loar/ G. R. Southworth (ESD) C. Kimbrough (Y-12)	Analysis of water quality data
11-21-86	X		D. Melgaard (TDHE) J. M. Loar (ESD)	Call received but no interaction
11-21-86		X	W. Schacher/ J. Evans (TWRA) J. M. Loar et al. (ESD)	Assist with fish survey
11-22-86		X	W. Schacher (TWRA) J. M. Loar/ G. R. Southworth (ESD)	Assist with fish survey
11-22-86	X		J. M Loar (ESD) T. R. Butz (Y-12)	Update on fish kill
11-23-86		X	W. Schacher (TWRA) J. M. Loar (ESD)	Assist with fish survey
11-23-86	X		J. M. Loar (ESD) T. R. Butz (Y-12)	Update on fish kill
11-24-86	X		J. M. Loar (ESD) B. Clark (TDHE)	Update on fish kill
11-24-86		X	ESD/Y-12/DOE	Exchange of information on fish kill
11-24-86	X		C. L. Stair (ESA) J. M. Loar (ESD)	Update on fish kill
11-25-86	X		J. M. Loar (ESD) C. C. Hill (Y-12)	Update on fish kill
11-26-86	X		J. M. Loar (ESD) B. Clark (TDHE)	Update on fish kill
11/26/86	X		J. M. Loar (ESD) C. C. Hill (Y-12)	Update on fish kill
12-01-86		X	ESD/Y-12/DOE	Exchange of information on fish kill
12-01-86	X		C. C. Hill (Y-12) J. M. Loar (ESD)	Content of press release
12-08-86	X		J. M. Loar (ESD) W. Schacher (TWRA)	Update on dead fish count
12-16-86		X	ESD/Y-12/DOE/TDHE/EPA	Summary of fish kill

[a]ESA = Environmental and Safety Activities (MMES Control staff); TWRA = Tennessee Wildlife Resources Agency; TDHE = Tennessee Department of Health and Environment.

UCN-7721B (2 1-86) MLB 1/29/93

OAK RIDGE Y-12 PLANT INFORMATION CONTROL FORM

DOCUMENT DESCRIPTION (Completed By Requesting Division)

Document No.	Author's Telephone No.	Acct. No.	Date of Request
MS/ChR-301871/K-25	6-8475		

Unclassified Title: Evaluation of Fish Kill on November 21, 1986 - Upper East Fork Poplar Creek

Author(s) (Suzanne Sandberg)

TYPE: ☐ Formal Report ☐ Informal Report ☐ Progress/Status Report ☐ Co-Op Report ☐ Thesis/Term Paper

☐ Oral Presentation (identify meeting, sponsor, location, date):

☐ Journal Article (Identify Journal):

☐ Other (Specify):

Document will be published in proceedings ☐ No ☐ Yes

Document will be distributed at meeting ☐ No ☐ Yes

Document has patent or invention significance ☐ No ☐ Yes (Identify)

Document has been previously released ☐ No ☐ Yes (Reference)

DIVISION REVIEW AND APPROVAL (Completed By Requesting Division)

TECHNICAL CLASSIFICATION REVIEW (Divisional Classification Representative)

Title(s): Unclassified Abstract: NA

DOCUMENT: Level Unclassified Category NA

Sara H. Welch 1/29/93

Signature Date

DOCUMENT REQUEST APPROVED (Division or Department)

Signature Date

Signature Date

THE REMAINDER OF THIS FORM TO BE COMPLETED BY THE TECHNICAL INFORMATION OFFICE

DISTRIBUTION

☐ Internal Distribution

☐ External Distribution

TID-4500 Category ______ or ______ Copies to OSTI

ANNOUNCED IN: ERA Atomindex (Available from NTIS)

M-3679 Category

ANNOUNCE IN: ☐ AWDR (Available from OSTI) ☐ ANCR

Distribution:	UCN-7721B	DOE F-1332.15	Document
Y-12 Central Files	Y-12 RC	Y-12 RC	Y-12 RC
TIO File			
Suzanne Sandberg			

Distribution Remarks: Cleared for Public Release ChemRisk

APPROVAL AND RELEASE

Date Received	Date Initiated
1-29-93	1-29-93

[2] CLASSIFICATIONS: U

Title(s): ______ Abstract ______

DOCUMENT:

Level U Category ______

Weapons Data ______ Sigma ______

J. D. Smith 1-29-93

Y-12 Classification Office Date

☐ Editor Date

[3] Patent Office [signature] 1/29/93 Date

☐ Other Date

☐ Other Date

APPROVED FOR: ☐ Declassification ☐ Release subject to use of the following admonitory markings and conditions:

☐ Disclaimer ☐ Copyright ☐ Patent Caution ☐ Other

[signature] 2/1/93

Technical Information Office Date

Conditions/Remarks:

ChemRisk Document Request Transmittal Form

(This section to be completed by ChemRisk)

Name S. Sandberg / Division ISD is requested to provide the following document

Address ______

Date of Request 12/10 Expected receipt of document 12/21

Title of requested document Evaluation of Fish Kill...

Document Number 301871

Access Number of Document ______ Date of Document 1/9/87

(This section to be completed by Derivative Classifier)

Derivative Classifier Sara H. Welch Phone 4-2864

Date document transmitted to Dr. Quist ______

Date release received from Dr. Quist ______

PUBLIC RELEASE STAMP attached to each copy of document (YES NO)

Date document sent to reproduction ______ Expected Return ______

Delivered to DRC by ______ Date ______

(This section to be completed by DRC)

Received by DRC ______ Date ______

Processed ______

Mailed ______

1993 FEB -3 PM 5:37

OAK RIDGE K-25 SITE DOCUMENT RELEASE FORM

Person requesting release ~~JENNIFER LAMB (CHEMRISK)~~ Telephone No. 4-0745

Mailing Address K-1200 MS-7262 Division or Organization

Date by which release is required (Standard processing time is 5 working days. Some documents require special review and the processing time will be longer).

Note: Two copies of the document must generally be provided to the Classification and Information Control Office with this request. Only one copy of photos and videotapes is required. Documents that include photos must be accompanied by "originals" of the photos.

Approval of request for Classification and Information Control Office to release document (department head or higher):

Signature: Date

DOCUMENT DESCRIPTION (to be completed by requester)

Document number UNNUMBERED/301871 Pages 28

Document title EVALUTATION OF FISH KILL ON NOVEMBER 21, 1986 - UPPER EAST FORK POPLAR CREEK

Author(s) (indicate other divisions or organizations, if applicable) GG FEE

Document type (See Doc. Prep. Guide, Chs. 1 and 2, for definitions of document types):

- ☐ Formal Report ☐ Progress Report ☐ Informal R&D Report ☐ Abstract ☐ Drawing
- ☐ Administrative ☑ Correspondence ☐ Internal Technical Data ☐ Photo ☐ Other Visuals
- ☐ Journal Article (identify journal):
- ☐ Oral Presentation (identify meeting, sponsor, location, date):

Will oral presentation be published in program, booklet, brochure, etc.? ☐ Yes ☐ No ☐ Not Known

Will copies of the oral presentation be distributed ☐ before, ☐ after, ☐ during the meeting? ☐ No distribution will be made.

☐ Other (specify):

Purpose of release HEALTH STUDY FEASIBILITY PROJECT

Previously cleared documents containing similar information

Is copyrighted material contained in this document? (If present, attach release.) ☐ Yes ☑ No

Remarks

CLASSIFICATION INFORMATION (to be obtained by requester)

Was the work reported in this document funded, in whole or in part, by a classified program at Martin Marietta Energy Systems, Inc.?

☐ No ☐ Yes (Name of program:)

Is the subject area of this document closely related to a prior or current classified program at Martin Marietta Energy Systems, Inc.?

☐ No ☐ Yes Within the Department of Energy? ☐ No ☐ Yes

Name or Description of applicable program(s)

Additional remarks

This document contains no classified information.

Derivative Classifier signature *Sara K. Welch* Date 1/27/93

UCN-87 (1 7-91)

DISTRIBUTION LIMITATIONS (If any) (completed by requester)

☐ Unrestricted, unlimited

Distribution may be limited because this document contains information that is:

☐ Unclassified Controlled Nuclear Information *
☐ Naval Nuclear Propulsion Information *
☐ Sensitive Nuclear Technology *
☐ Safeguards Information *
☐ Applied Technology *
☐ Gov't Confidential Commercial Information *
☐ Small Business Innovation Research *
☐ Cooperative R&D Agreement *
☐ Export Controlled *
☐ Proprietary
☐ Official Use Only
☐ Other

* Generally identified by sponsor

Remarks: ______________________________

PATENT INFORMATION (completed by requester)

Does this document disclose any new equipment, process, or material? ☐ Yes ☐ No

If yes, list the patent significance and identify page number(s) and line number(s) in the space immediately following (or attach separate pages).

PATENT SECTION ACTION (completed by Patent Section upon request by the Classification and Information Control Office)

☐ Document may be released for publication
☐ Document must be reviewed by DOE Patent Group before release
☐ Document contains patentable information and may not be released at this time

Remarks ______________________________

Patent Section Representative ______________________ Date ____________

CLASSIFICATION AND INFORMATION CONTROL OFFICE ACTION (completed by Classification and Information Control Office)

Classification Office Action Taken:
☐ Not approved for release (see below)
☐ Approved for release without change
☐ Approved for release with changes (see below)

Classification Officer signature ______________________ Date ____________

Technical Information Office Action Taken:
☐ Not approved for release (see below)
☐ Approved for release without change
☐ Approved for release with changes (see below)

Technical Information Officer Signature ______________________ Date ____________

Send to OSTI? ☐ Yes ☐ No

Category Distribution: ______________________